of which according to the usual method of correlation tables occupies much time, while the subdivision into larger groups makes the results inaccurate. The following method of calculation secures a great saving of time and labor. The averages and mean square variabilities of all the variables must be determined. By forming the differences between any series of pairs, we find the values of $x - y$, which may be treated like any variable. Indicating averages by brackets, we have

$$[(x-y)^2] = [x^2] + [y^2] - 2[xy]$$
$$= \sigma_x^2 + \sigma_y^2 - 2r\sigma_x\sigma_y$$
$$-r = \frac{[(x-y)^2] - \sigma_x^2 - \sigma_y^2}{2\sigma_x\sigma_y}$$

For a single correlation there is not much saving of time in this method of calculation, but in multiple correlations a very large amount of labor is saved.

A similar device may be used in the calculation of correlations of fraternities. When the deviations for members of a fraternity are designated by x_1, x_2, $x_3 \cdots x_n$,

$$[(x_1 + x_2 + x_3 + \cdots + x_n)^2] = n\sigma_x^2(1 + \overline{n-1}r)$$
$$r = \frac{[(x_1 + x_2 + \cdots + x_n)^2]}{n(n-1)\sigma_x^2} - \frac{1}{n-1}$$

A similar method will allow the determination of the average correlation of a large series of variabilities. By reducing each variable to multiples of its variability, we find

$$\left[\left(\frac{x_1}{\sigma_1} + \frac{x_2}{\sigma_2} + \cdots + \frac{x_n}{\sigma_n}\right)^2\right] = n + r_{1,2} + r_{1,3} + \cdots + r_{n-1,n}$$
$$[r] = \frac{\left[\left(\frac{x_1}{\sigma_1} + \frac{x_2}{\sigma_2} + \cdots + \frac{x_n}{\sigma_n}\right)^2\right]}{n(n-1)} - \frac{1}{n-1}$$

Correlations of phenomena that can not be measured, but only counted, may be treated in the following manner: If two events that have the probabilities p_1 and p_2 are correlated, we may say that those cases in which the event 1 occurs have the probability 1, or a deviation from the normal probability $1 - p$.

Those cases in which the event 1 does not occur have the probability 0, or a deviation from the average probability of $-p_1$. If we call p_2' the probability of the event 2 when event 1 occurs, p_2'' the probability of event 2 when event 1 does not occur, and q_1 the coefficient of regression of 2 upon 1, we have

$$p_2' - p_2 = q_1(1 - p_1)$$
$$p_2'' - p_2 = -q_1p_1$$

Thus the phenomenon corresponds strictly to that of measurable variables, and the procedure may be followed that is applied in the calculation of the coefficient of correlation of measurable variables. It follows that

$$p_{1,2} = p_1p_2 + q_1p_1(1 - p_1)$$

We designate, as usual,

$$q_1 = r\frac{\sigma_2}{\sigma_1}$$
$$q_1 = r\sqrt{\frac{p_2(1-p_2)}{p_1(1-p_1)}}$$
$$p_{1,2} = p_1p_2 + r\sqrt{p_1(1-p_1)p_2(1-p_2)}$$
$$r = \frac{p_{1,2} - p_1p_2}{\sqrt{p_1(1-p_1)p_2(1-p_2)}}$$

The correlation between a measurable and an unmeasurable quantity can be determined in a similar manner. When the measurable quantity is grouped as an array of the measurable quantity, we find, using the same symbols as before,

$$[x'] = q_1(1-p)$$
$$[x''] = -q_1p$$
$$\therefore \quad [x'] - [x''] = q_1$$

or
$$q_1 = \frac{[x']p}{p(1-p)}$$
$$r = \frac{[x']p}{\sigma_x\sqrt{p(1-p)}} = \frac{-[x''](1-p)}{\sigma_x\sqrt{p(1-p)}}$$

From these formulas, multiple correlations may be calculated according to the same formulas as those used for measurable variables.

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The Enzymes of Ova—Influenced by Those of Sperm?

Some few summers ago, while working in the laboratories of the Biological Station at Woods Hole, Mass., the writer began some experiments to ascertain whether or not the action of the enzymes of ova were in any measure increased or decreased by those of sperm. The problem was suggested by the work of other investigators which showed that some enzymes have an interdependent action. It was also conceived that the process of fertilization might be due to the acceleration of

the enzyme action of the eggs by virtue of the presence of the enzymes of the spermatozoa. If such were the case the accelerated enzyme action might be demonstrated in the test-tube.

The results of the tests were in no measure conclusive, and the writer had hoped that he would have an opportunity to pursue the problem further, and for these reasons no reports on the investigation were made. As it seems that the work in which the writer is now engaged will prevent his having opportunity to repeat the experiments, a succinct general report of the work will here be made.

Star fish were chosen because they afforded a plentiful supply of both eggs and sperm, and because they were easily obtained from the waters about Woods Hole. The males and females were carefully washed and kept separate. The eggs and sperm were thoroughly ground by mortar and pestle; the power of each to split starch, fat and hydrogen dioxide was tested. Three tubes were used in each case. In tube 1 was placed 5 c.c. of ground eggs, 5 c.c. of starch solution and 5 c.c. of water. In tube 2 was placed 5 c.c. of ground sperm, 5 c.c. of starch solution and 5 c.c. of sea water. In tube 3 was placed 5 c.c. of the ground eggs, 5 c.c. of the ground sperm and 5 c.c. of the starch solution. The tubes were allowed to stand at room temperature for a considerable time, after which the contents were tested for sugar by the reduction test. It was found that there was only the slightest trace of reducing substance in tubes 1 and 2, whereas in tube 3 there was a very distinct amount present. These experiments were repeated perhaps six to ten times and the results were conflicting. They were neither consistently negative nor consistently positive. Nor were they sufficiently often positive to convince one that when they were positive it was not an accident. Comparable experiments to the above were carried out with butyric ether and hydrogen dioxide. The results were equally exasperating as those with starch. Whether the positive results were entirely the result of error or whether the negative results were due to the use of unmatured eggs or sperm it is impossible to say. It seems, however, that the results were such as to justify a careful repetition of the experiments, and it is hoped that some capable man who is interested in the problem will take it up.

It is a well-recognized fact that a large number of the female star fish contain a large number of eggs that appear in every way normal, mature and ready for fertilization and yet will not develop when sperm is placed with them. It seems that it may be possible that this would account for the varying results.

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NOTE ON THE ACCESSORY CLEAVAGE IN THE HEN'S EGG[1]

HARPER[2] has shown that polyspermy normally occurs in the pigeon's egg. His figures indicate that from twelve to twenty-five sperm-nuclei are formed in the egg. Only one of these, however, becomes a functional sperm-nucleus; the others migrate from the points of entrance to the periphery of the disc where they become active, dividing and giving rise to the "accessory cleavage." There is thus formed around the primary cleavage, which is produced by the divisions of the segmentation nucleus, an area of small cells. Blount[3] has later shown that these supernumerary sperm-nuclei live but for a short time, and then degenerate. She estimates the time of their disappearance as coming between ten and twelve hours after fertilization.

In the hen's egg accessory cleavage has neither been figured nor described. On taking up the study of the early development of this egg I was, therefore, greatly surprised to find an accessory cleavage. Not only can the furrows be seen in the living egg, but I also have preparations of surface views in which they stand out with diagrammatic clearness.

[1] Publications from the Zoological Laboratory of the University of Texas, No. 96. The writer is greatly indebted to the trustees of the Elizabeth Thompson Science Fund for a grant with which to carry on this work.

[2] E. H. Harper, "The Fertilization and Early Development of the Pigeon's Egg," *Amer. Jour. of Anat.*, Vol. III., No. 4.

[3] Mary Blount, "The Early Development of the Pigeon's Egg, with Especial Reference to the Supernumerary Sperm Nuclei, the Periblast and the Germ Wall," *Biol. Bull.*, Vol. XIII., No. 5.